The American Society of Naturalists.
The American Philosophical Society.
The American Academy of Arts and Sciences.
The Association of American Anatomists.
The Association of American Physicians.
The Association of Pathologists and Bacteriologists.
The Astronomical and Astrophysical Society of America.
The Botanical Society of America.
The Geological Society of America.
The American Mathematical Society.
Active members of the American Ornithological Union.
The American Philosophical Association.
The American Physical Society.
The American Physiological Society.
The American Psychological Association.
The American Society of Bacteriologists.
The Society of Plant Morphology and Physiology.
The American Zoological Society.

The following resolution was referred to the committee on policy of the association:

Resolved, that the year book of this association be hereafter sent bound to such members as may notify the permanent secretary of their desire to receive it in that form. Binding to be in cloth or boards, as the treasurer and secretary may think proper.

Dr. W. H. Hale introduced the following resolution, which was adopted:

Resolved, That the American Association for the Advancement of Science hereby extends its hearty congratulations and best wishes to Dr. Martin H. Boye, a founder of this association, and the only surviving founder of the parent association, that of American Geologists, afterwards called the American Association of Geologists and Naturalists, which was founded in this city in 1840, Dr. Boye being present at that time, as well as at the founding of the American Association for the Advancement of Science in 1848.

Professor C. M. Woodward introduced resolutions thanking the officers of the University of Pennsylvania and other institutions that had entertained the association and these were unanimously adopted.

At the meeting of the general committee, Friday evening, it was decided to hold the next meeting in New Orleans, the work of the association to begin Friday, December 29, 1905. Boston was recommended as the place of the meeting in 1906.

The following officers were elected for the New Orleans Meeting.

President—Professor C. M. Woodward, St. Louis, Mo.

Vice-Presidents:

Section A—Professor W. S. Eichelberger, Washington, D. C.
Section B—Professor Henry Crew, Evanston, Ill.
Section C—Professor Chas. F. Mabery, Cleveland, Ohio.
Section D—Professor F. W. McNair, Houghton, Mich.
Section E—Professor Wm. North Rice, Middletown, Conn.
Section F—Professor H. B. Ward, Lincoln, Neb.
Section G—Dr. Erwin F. Smith, Washington, D. C.
Section H—Dr. Geo. Grant McCurdy, New Haven, Conn.
Section I—Professor Irving Fischer, New Haven, Conn.
Section K—Professor Wm. T. Sedgwick, Boston, Mass.

Permanent Secretary—Dr. L. O. Howard was elected for a period of five years beginning August, 1905.

General Secretary—Professor C. A. Waldo, Lafayette, Ind.

Secretary of Council—Professor John F. Hayford, Washington, D. C.

Secretary Section K—Dr. Wm. J. Gies, New York City, N. Y.

CHARLES S. HOWE,
General Secretary.

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*LINES OF PROGRESS IN ENGINEERING.**

THE engineering army, like the myriads of well-trained, well-equipped and well-organized soldiers of the Mikado, stretches from high ground to high ground along an extended front, facing the hosts of conservatism who are entrenched behind moats

* Address of the vice-president and chairman of Section D—Mechanical Science and Engineering, 1904.

of difficulties, redoubts of prejudices, batteries of tradition and in citadels of ignorance. Like the Japanese, the division commanders, looking well to their supplies of ammunition (*i. e.*, correct theories) and their daily rations (*i. e.*, materials of construction and shop practise), push forward now at one point and now at another, capturing hill after hill, now on the right, now on the left, and now in the center. The army of science never retreats; it forever forces back the frontiers of darkness, and solves problem after problem from the endless list of secrets with which the storehouses of nature are filled.

It is a glorious thing to belong to this engineering army, to rejoice in its triumphs and to share in its rewards. Its success is not accidental; its triumphs are not matters of chance. Engineering blood always tells. Just as we train our best soldiers and sailors at West Point and at Annapolis; and as our appliances at military and naval schools keep pace with the arts of war on land and sea; so our schools of engineering, if they are up-to-date institutions, keep pace in the theories they teach and in the laboratories they equip with the best engineering practise. Every advance at the front (to resume my simile) means an advance of all supplies and in the enlisting and training of recruits. I am by profession a recruiting officer, and I am engaged with my fellow officers in training and equipping men for the firing line and the front rank. That the new material we send forward may be just what is wanted, we must have information as to the progress making and the next points of attack. In short, our schools of engineering must know the lines of engineering progress.

I am well aware that I shall not be able to touch upon many of the important matters which my subject is sure to bring up, and I can not expect to take them in the order of their importance. Probably no two of us would agree upon their relative importance; one's environment has so much to do with what lies just beyond his horizon; so I doubt not you will supplement my statement with most interesting and valuable suggestions.

THE UTILIZATION OF WASTE ENERGY.

While much has been done and much more is doing at waterfalls and river rapids, large and small, the work of saving the energy which now runs to waste has but just begun. When the great waterfalls are utilized the rapids will remain. We are lost in wonder when we calculate the possibilities. Measure the volumes which rush over the 'Sault St. Marie,' as the waters of Lake Superior drop to the level of Lake Huron; and then again put your measuring rods into the vastly greater volumes which plunge and rush from Lake Erie to Lake Ontario; and still again through the rapids of the St. Lawrence to the sea level. At every vantage ground, the work of utilization has begun and no man now living will see that work stop. Turn next to smaller streams and mountain torrents—what fields open up to the hydraulic and electric engineers! Mountain reservoirs will serve the triple purpose of preventing destructive floods, of saving the energy for useful work and of aiding irrigation. At every count the doors open wide for the best of engineering enterprise and the best of engineers, hydraulic, mechanic, electric, irrigation, and the echo of each department must be heard in the engineering lecture-room and laboratory. The electric transformer has made the transmission of energy possible from mountain slopes to far cities, and has unlocked bewildering amounts of energy at thousands of points deemed hitherto inaccessible. No one can see far into the future, but we all easily see the dawn of a new era of energy saving. The streets of this city may yet

be lighted by the energy which now runs to waste at Niagara. In St. Louis we look to the slopes and canyons of the Rockies for our supply of sweet, wholesome water—we may yet look to the same regions for the energy to drive our cars and run our mills.

COMBUSTION ENGINES.

The clumsy steam-engine, with its wasteful furnace, its huge boiler and chimney, is doomed. It has done great work in producing available energy and in wasting still more. It has played a most important part in modern civilization, and it deserves well at our hands, but nothing can stay the decree of progress. Sentence will soon be pronounced, but the day of execution has not been set. I never expect to see the day when steam power plants will cease to exist, but my children will see such a day.

Think for a moment of the present complicated, indirect method of procedure for converting the energy stored in coal into mechanical energy in a moving piston or a revolving shaft. Coal and air are fed into a furnace where combustion converts them into great volumes of a mixture of hot gases. The greater part of the heat and all the volume of these gases escape through the chimney; a small part of the heat only is drawn off by the steel shell and tubes of a boiler and transmitted to a body of water, which is thereby transformed into steam. The steady generation of steam against high pressure, added to its expansion as the pressure is reduced, enables it, when conducted to a cylinder, to drive a piston or revolve a shaft, thereby producing mechanical power. The clumsiness of the operation is equalled only by its wastefulness, which varies from 88 per cent. to 95 per cent.

The problem to-day is: What is the most direct and most economical road from coal to moving machinery? Engineers are attacking this problem on all sides, and attacking it successfully—gas-engines, and combustion-engines of various sorts bear witness. The future prime-mover will burn (not explode) its fuel in the working cylinder, and the piston will be driven, first by the products of combustion as their volume increases, and secondly by their expansion against a diminishing resistance. I predict great things of the Diesel motor. Originally it was designed to burn powdered coal mixed with hot compressed air; but crude petroleum was found to be preferable. So long as oil flows abundantly from wells, oil will generally be used, but powdered fuel, native or prepared, will doubtless prevail ultimately. The economy and directness of the combustion motor can not be excelled, and when a few years of study and experiment have been applied to the work of simplifying the mechanism (it was a century from James Watt to a triple-expansion Corliss), we may expect it to come into general use for all great central power stations.

The vitality of the steam-engine is due to-day to the mechanical perfection of its design. Its simplicity is marvelous. It is started and stopped with the greatest ease and it almost takes care of itself. The invention of the steam turbine has probably given to the furnace and steam-boiler another lease of life. The wonderful adaptability of the turbine for electric generators is something which was not anticipated.

Will not some one design and construct a combustion engine which shall consume continuously oil and compressed air, thus maintaining a high pressure in a gas chest and driving a turbine with the products of the combustion used expansively as is now done with steam? The proposition is an attractive one, both for the lecture room and for the engineering laboratory. It is sufficient now to call attention to its pos-

sibility, and to indicate a point for study and progress.

It will not be amiss for me to quote the figures given me by the engineer in charge of the Diesel engines which drove the generators for power and light in the 'Tyrolean Alps' at the late world's fair in St. Louis.

These engines, three in number, of 225 horse power each, were the observed of many observing engineers during the seven months of the fair. The assistant engineer in charge kept daily records of the work done, and fuel used, and kindly gave me a sample of his reports. The details are extremely interesting. The work was measured at the switchboard, no allowance being made for loss of energy in the engine, air pump and generator. The total work of the three engines between noon and midnight was 2,768.5 K.W.H. This is equivalent to 3,711 H.P.H.

Total fuel used (Indiana oil), 266 gals.
Fuel per 100 K.W. hours, 9.58 gals.
Fuel cost in car-tank lots, 3c. per gal.
Cost per 100 K.W.H., $0.287.
Cost of the day's fuel, $7.98 or 2.15 mills per H.P.H.

Thus one cent paid for the fuel for one horse power for four hours, forty minutes.

The three engines worked under about two thirds of a full load and used three gallons of lubricating oil during the day.

The above figures seem to me little less than remarkable.

While still wasteful, as nature measures energy, these engines are several times as efficient as the better styles of ordinary steam-engines. Doubtless they lack simplicity and the certainty of action which comes from experience and close study; but I can not help feeling that the road to the future 'prime mover' runs hard by the construction shops of an internal-combustion engine. Let students and professors take warning.

ARTIFICIAL CENTERS OF POWER.

One of the most important openings for future engineering enterprises is the establishment of large power centers, not only where water power is available, but where fuel is abundant as well.

Take, for example, the vast coal mines in the vicinity of the city of Philadelphia and those in the vicinity of St. Louis. In each case the power for industrial establishments and all kinds of moving machinery, large and small, in use in the city, including the street cars and the rolling stock on all roads, can well be furnished by electrical currents from large generating establishments near the mines. Add to the above the establishment of gas works sufficiently large to furnish all the gas needed for illumination, for gas-engines, for heating and cooking purposes in a great city. In the case of St. Louis those gas works should be near the extensive coal mines of Belleville and other coal-producing regions only a few miles from the city.

The effect of these two great steps forward upon the physical and sociological characteristics of a city can hardly be overestimated. The ultimate economy and convenience of such installations are enough to justify them. We have yet to learn how cheaply fuel gas and electric currents can be furnished to large concentrated groups of consumers. But omitting all questions of mere financial economy, what a saving in health, beauty and enjoyment! The London fogs which we hear so much about are produced largely by London smoke, and the prevention of smoke will to a very great extent be the prevention of the fog. I look forward to the day when, instead of a small volcano of smoke from a brick crater above every house, St. Louis will have all its heating and cooking done by gas, and all power will be furnished by electric currents, or by gas and combustion-engines,

both gas and electricity coming from the gas works and power plants at the mouths of the coal mines in Illinois. What an era of cleanliness and comfort this presages! This era of cleanliness will be brought about by the engineers. Hence engineering education must see to it that engineering students are prepared for their high mission. The proposed 'Million Club' of St. Louis bears no comparison with a possible 'Clear Sky Club.' The former proposes to seduce 250,000 non-resident smokemakers into joining the 750,000 smokemakers already resident in St. Louis, thereby making smoke enough to shut out the sun entirely (they almost did it during a whole week last November). The 'Clear-Sky Club,' on the other hand, will propose to eliminate all smokers by sending coal-burning power plants to the mines, thereby leaving the city so clean and beautiful that 250,000 lovers of pure air, clear skies and godliness will seek homes among us of their own accord. The elimination of smoke, soot and ashes will make St. Louis absolutely bright and clean, and similar improvements here would go far towards producing the same beneficial results in the city of Philadelphia. Already our cities have, or are making arrangements for, an abundant supply of pure water. This has been and still is a great branch of engineering, and it deserves an important place in our schools of engineering. We must next provide pure air and a clear sky.

These steps forward involve no very great addition to our engineering knowledge, but they give opportunity for engineering enterprises, and they show most clearly how essential cooperation is in such work. Large power plants and extensive gas works require much private capital, unless we fly to the extreme of public ownership. The economic construction of large power plants and gas plants; the laying of pipe lines and an unprecedented amount of electric cables, all or nearly all underground, constitute a great field and furnish great engineering opportunity.

THE PURIFICATION OF RIVERS.

We have nearly reached the limit in river pollution. The public welfare will soon make an imperative demand for a halt. A great city like Chicago shall no longer load with poison a little stream like the Illinois, nor foully pollute a great river like the Mississippi. Let me frankly admit that even the city of St. Louis shall not forever dump and pour its refuse into the Mississippi River.

When the national government takes up the function of guarding every stream from pollution (and no state government can deal effectively with the problem) we shall have a great extension of the sphere of sanitary engineering. The recent discoveries by Dr. George T. Moore, of the Department of Agriculture, suggest the possibility of purifying a polluted stream so as to make it not only clear and sweet, but absolutely free from algæ and all harmful bacilli. The proper disposition of house drainage and the refuse of factories is already a live engineering problem in Europe, and American engineers must no longer neglect it. The study of diseases and their prevention is forcing its way into engineering schools, as preliminary to extensive engineering practise. Whatever form the solution of the problem may take, it will involve both chemical and hydraulic engineering, and the fundamental principles of both must be carefully laid in our schools.

TUBULAR CONSTRUCTIONS.

In the near future we are likely to make great progress in the construction of rolling stock and moving machinery, as well as in the construction of bridges and buildings.

The adoption of electricity by railroads for all kinds of traffic will result, in the first place, in the disappearance of the

heavy locomotive. So long as the locomotive was needed to pull a long train of cars, great weight was necessary, and the weight of railway engines and the strength of bridges have been increasing at a rapid rate. We saw a locomotive at the recent fair at St. Louis weighing over 200 tons. It was a monster, indeed. Should such locomotives become common, every bridge in the country would have to be rebuilt.

But when each car, whether for passengers or for freight, has its own motor and drives itself, the heavy locomotive is no longer needed. Moreover, the car itself should be made as light as possible consistent with strength. Weight is of no advantage to a self-driven car. The bicycle has taught us a great lesson in the art of construction. A maximum of strength and stiffness with a minimum of weight. This already prevails in girders and bridge constructions. The same principles should be applied to all rolling stock and moving machinery. Tubular axles, tubular spokes, tubular fellies, tubular shafts, tubular everything is to be the law of future construction. All the great steam-engines and propellers already have hollow shafts, and I predict an enormous increase in the amount and precision of hollow steel tubing manufactured and used in the next ten years. The mechanical and material advantage of tubular shafting is easily stated. Thus: (1) If a solid cylindrical shaft be compared with a hollow shaft of the same weight per foot of length, but whose exterior diameter is n times as great, the strength of the hollow shaft in torsion is $2n - 1/n$ times as great as that of the solid shaft. (2) If only equal strength is required, the solid shaft having one nth of the diameter of the tube, will weigh $2n - 1/n^2$ times as much. For a numerical example: (*a*) A thin tubular shaft four inches in diameter is seven and three fourth times as strong as a solid shaft one inch in diameter which weighs the same per linear foot.

(*b*) A solid shaft weighs seven and thirty-one thirty-seconds (call it eight) times as much as a tubular shaft of equal strength and four times its diameter.

The ratio of stiffness of the tube to that of the solid shaft is even greater.

At the recent St. Louis fair a prize of $2,500 was offered for the lightest motor per horse power. Motors up to 100 horse power were eligible. The prize was not awarded, for the reason that inventors and constructors of motors were not prepared to submit their apparatus to the rigid tests required for efficiency and durability; but the offer was made with distinct intention of stimulating the construction of motors which should be suitable for vehicles where lightness combined with great strength is a desideratum, such as in automobiles and air-ships.

STEEL AND CONCRETE AND CEMENT.

I scarcely need call your attention to the important part which steel-concrete constructions are destined to play in future structures. Originally all important bridges, walls and dams were built of stone, and masonry flourished as a fine art. Arches, groined and cloistered, segmental and gothic, elliptic and parabola, combined to make cathedrals and chapels beautiful, and bridges stately and strong as well as durable. Then came the era of iron and steel, and stone bridges were built no more. Steel trusses, posts and girders took the place of stone walls and granite arches. We are now going back to masonry walls and to masonry bridges, but the masonry is no longer granite; it is concrete reenforced by steel. Evidently the opening for engineering theory and engineering enterprise is most extensive. The new material is not subject to corrosion, so it will not be eaten up by rust. It is incombustible, and

is not easily melted or weakened by heat, and above all it is inexpensive and easily handled. The field is a great one, and both the theory and the practise of steel and concrete combinations enter, or should enter, into the curriculum of every student of civil engineering and architecture. In the Austrian building at the recent fair in St. Louis there was a model of the centering of an arch, evidently steel-concrete, of 80 meters span (262 feet). You will remember that the beautiful and imposing 'Cabin John Bridge,' built of granite, in Washington, D. C., the greatest stone arch in the United States, has a span of 220 feet.

The recent enormous increase in the manufacture of Portland cement is an indication of the coming demand. It has taken thousands, perhaps millions, of years in the laboratory of nature, to produce the masses of granite and the layers of marble and limestone; the engineer and the chemist, working together, produce from the abundant supplies of material near at hand an artificial masonry in a few hours. Of its strength and durability the engineering laboratory and a brief experience tell us much. The verdict of a thousand years is still to be rendered, but here again the hand of promise points our way.

AERIAL NAVIGATION.

Above I casually mentioned air ships. You must bear with me while I say several things about aerial navigation.

We have been accustomed to regard the problem of practically navigating the air as one which could not be solved, or, at any rate, as a sort of fad hardly deserving of mention in connection with engineering. It will be remembered that the late eminent engineer, Professor J. B. Johnson, would not admit that aerial navigation was a possibility. He classed it with the problem of perpetual motion. But a careful examination of all the conditions seems to me to point towards the possibility of progress, and all that we can at present claim for many desirable improvements is that they admit of progress. We can not with any confidence predict the rate of progress. Some of the things I have already pointed out bear directly upon the problem of aerial navigation; two in particular: The use of tubular constructions for the maximum of strength and the minimum of weight; and the construction of motors which are strong and light; but many problems must be solved before we can really navigate the air.

It was my privilege to be connected with the discussion of aerial matters at the late fair in St. Louis. Without my knowledge I was selected as the president of the aeronautic congress, in which the problems of aeronautics were carefully discussed. That congress had no functions whatever in regard to aerial exhibits, or attempts to exhibit air ships, at the world's fair. The latter feature of the fair I regret to say was a deplorable failure. The greater part of the failure was inevitable, since aerial experimentation is expensive and difficult, and it has very rarely been undertaken by scientific people. What has been anywhere in that direction has been for the most part crude, ill-advised and unscientific, and failures have generally attended any attempts to actually navigate the air. Of course there are exceptions in the character of the investigations made. I could mention four Americans who are approaching the problem carefully and on scientific lines. Some of their investigations and experiments are full of promise for the future of aerial navigation.

So far as the failure of the spectacular part of aeronautics at the fair was concerned, that failure was due very largely to the vandalism of some crazy crank or rival, who cruelly mutilated the air ship brought over by Santos Dumont at great expense, to be used during the summer in

St. Louis; and especially was the failure due to the most unfortunate and unwarranted charge which a police officer made in response to a call for a report in regard to the mutilation of 'Santos-Dumont No. 7.' Being unable to get any clue to the guilty wretch (who had plenty of time to slip in and slash the gathered silk in hundreds of places while the guard sipped his coffee in a booth a few hundred yards away), and feeling doubtless that he must give some explanation, he actually stated that in his opinion the injury was inflicted either by Santos-Dumont himself or by some one of his men. No more injurious, unwarranted or insensate charge could have been made, and no person who was in any way acquainted with Santos Dumont could have made it; and yet that charge became current in the newspapers and was half believed by a great many very respectable people far and wide. Doubtless the currency of that charge did much to discourage and repel Santos Dumont from our shores. That he should have received such treatment in America was surprising and greatly to be regretted. It went far to give us a bad reputation in European circles. We are credited with hostility towards European inventors and experimenters. I trust Mr. Santos Dumont may eventually learn that Americans as a rule are fair-minded, generous and friendly towards all experimenters in every field. I trust he may learn that not one, so far as I know, of the gentlemen who were associated with him during his two visits to St. Louis sympathizes in any way, or to any extent, with the insinuations thrown out against him by the officer above referred to.

From this digression I now turn to the subject in hand, namely, the possibility of progress in the art of aerial navigation. Regarding progress in aerial navigation as entirely possible, I notice that it depends upon the solution of many problems, and no successful air-ship can reasonably be expected to appear until these problems are solved.

There are two lines of attack, which, while differing in one respect, have very much in common. Investigators are naturally divided into two classes: One seeking to devise methods for navigating the air as birds do, which gain support and propulsion solely from mechanical and muscular energy; and the other relying for support, more or less, upon the buoyancy of hydrogen gas, while securing propulsion by means of propellers. All are clearly interested in motors, whether the air-ship moves with or without the support of a bag of hydrogen. All are concerned with methods of management, and with the adoption of means for directing the movements of an air ship through the air.

If a gas bag is to be used, it is evident that the shape of the bag which involves the least amount of resistance is of first importance, and if that bag is to be a diminishing quantity, the ship must secure support from the use of aeroplanes or curved surfaces as the craft is driven rapidly forward. It is evident that the character of supporting surfaces and their distribution are matters of first importance in all cases. The number of preliminary lemmas which must be solved before the main proposition is reached is readily seen. The recent aeronautical congress concerned itself wholly with discussions and reports of experiments upon these preliminary matters, and I can truthfully say that excellent work was done.

I spoke of the gas bag as being a diminishing quantity. I wish to add a few words to make my meaning clear. When it was first proposed to propel an ocean ship by means of mechanical power, it was assumed as a matter of course that the

ship itself could float upon the water, and that mechanism was to be employed solely for the purpose of driving it forward and for steering it. In aerial navigation the case is different. The ship is not only to be driven forward, but it must be supported. The analogous case, therefore, is not that of an ocean ship, but of a heavy swimmer who must both support and drive himself forward. Swimming does not come to boy or girl by nature, and the skillful teacher furnishes a temporary support while the learner masters the art of using his hands, feet and legs correctly. Accordingly, he applies either a buoyant bag of air between the boy's shoulders, or the gentle lift of a string attached to a pole, and thus supports the learner while he masters the mechanical details of swimming. This exterior lift or support is a diminishing quantity as the pupil progresses, and when correct motions are learned and become automatic, the pupil swims and external aid is no longer necessary.

Similarly, as it seems to me, aerial navigation is to be accomplished. At first the craft may very properly be supported by a bag of hydrogen. Something must hold the structure which is to carry motor, propellers, fuel, ballast, steering apparatus, aero-planes, etc., above the ground, in comparatively still air, while tests can be made and skill in management can be acquired. Infinite patience, plenty of money and first-class engineering culture and skill will be required. The various elements must be studied one at a time, while a friendly gas bag holds the experimenter aloft. When an engineer can build a durable and well-portioned motor and system of propellers, which shall be as strong as twenty horses and only as heavy as twenty geese; and when he can drive his supporting bag of hydrogen through the air at the rate of twenty or thirty miles per hour, he can reduce the size of his bag and get support from aeroplanes and curved surfaces, and learn to manage them. The smaller the gas bag, the less the resistance of the air; consequently a greater velocity; consequently a greater lift of the aero-surfaces; and again a less demand upon the hydrogen —and so on, to final victory. American skill, ingenuity and experience will triumph provided that experience is cumulative. Men must learn from twenty failures how to succeed the twenty-first time in one thing. As I said: Patience, money and time are necessary. I wish Andrew Carnegie, or some other 'captain of industry' who is in danger of dying rich, would establish and endow an 'aeronautical experiment station and laboratory,' and then place it in charge of a physicist like Professor Zahm, and an accomplished mechanical engineer like Mr. Blank. In ten years such men, under such conditions, would go far towards a solution of the problem of aerial navigation.

FUNDAMENTAL PRINCIPLES.

Some one proposed to teach a nation patriotism by writing popular songs for its schools. There was a world of wisdom in the suggestion, for the foundations of character and the guiding principles of life are generally laid at school. That is why the great teacher is such a power in the world.

Is it not so in engineering? Are not a few fundamental propositions of mechanics what one must fall back upon when a new problem is encountered? And does not the probability of one's seeing new problems and of solving them depend very largely upon one's absolute mastery of those few fundamental propositions? If you agree with me and answer these questions in the affirmative, then it follows, in our opinion at least, that the lines of progress in engineering will depend largely upon the com-

plete equipment of our schools and the thoroughness with which the basic doctrines are instilled into the life blood of the students. It is said of Benjamin Franklin that he could not take a walk nor go on a journey without seeing all about him unsolved problems and new illustrations of universal laws; and with Franklin to see a problem was almost the same as to solve it.

MANUAL TRAINING.

I can not close this rambling address without referring to a recent improvement in secondary education which is likely to affect favorably engineering education, and through that education promote the future of engineering itself. I refer to the introduction into high schools and academies of the study of tools, materials and the mechanical processes. At the age of fifteen the expanding boy feels the thrill of increasing strength, and a natural hunger and thirst for contact with material things. The instinct to handle things, to do things, requires guidance or it becomes belligerent and destructive. The material universe is to be solved by every one for himself; if in no better way, it will be by pulling things to pieces to see how they are put together; by breaking things to see how strong they are; and by making new things if he only know how.

Then and there are the time and place for manual training; not for a trade or a profession, nor even for fun and pleasure; but for culture and a conscious mastery of tools and materials, and of the arts of construction. During the secondary stage of education the student should find himself and get an intelligent insight into the world of mind and matter around him. Both inborn aptitude and external opportunity should justify the coming engineer. The new educational feature goes far to develop the one and to discover the other. The fruit of well-organized and logical manual training is clear thinking, strong, vivid concepts, a world of knowledge gained first-hand, a power and habit of mental analysis of concrete problems—all of which admirably prepare the boy to take up, as a man, the study and practise of engineering. We have all seen something of this rich fruit, and have tested its value. In my judgment, it bodes well for engineering. Like Franklin, these young men (and they are swarming through our manual training schools and knocking in increasing numbers at the doors of our technical schools and colleges) will see things, and solve things, and make things move. The promise of the future is glorious; splendid is the era now dawning; fortunate in their opportunity are the young engineers with clear heads and skilled hands who are coming to the front; and happy are we who, to the best of our ability, are helping on the higher civilization which good engineering makes possible.

Calvin Milton Woodward.

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*PROBLEMS IN HUMAN ANATOMY.**

For the solution of the problems presented to him, the anatomist is by no means limited in his technique to the scalpel or the microscope, but justly claims the right to use every aid to research which other departments of science are able to furnish. His position, therefore, in the scientific field is determined by the standpoint which he occupies and from which he regards animal structures, rather than by any special means and methods employed for their study.

By common consent, anatomical material includes not only structures which may be easily dissected and studied with the unaided eye, but also those which tax the best

* Address prepared for the Section of Human Anatomy at the International Congress of Arts and Science, at St. Louis. Owing to the unavoidable absence of the writer, this addr ss was not delivered.